MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2017/2018

PGC0225 – GENERAL CHEMISTRY

(Foundation in Life Sciences students only)

12 OCTOBER 2017
9.00 a.m – 11.00 a.m

(2 Hours)

INSTRUCTIONS TO STUDENT

1. This question paper consists of **5** pages only excluding the cover page.
2. Answer **ALL** questions.
3. Please write all your answers in the answer booklet provided.
4. Distribution of marks for each question is given.
5. Calculator is permitted.

Instructions: Answer **ALL** questions.

Question 1 [20 marks]

a. Nitrogenous fertilisers contain the element nitrogen which is an essential nutrient for healthy plant growth. Two fertilisers are given below:
[Atomic mass: H = 1.0; C = 12.0; O = 16.0; N = 14.0]

- ammonium nitrate, NH_4NO_3
- urea, $CO(NH_2)_2$

Determine which fertilizer will provide the higher mass of nitrogen per kilogram of fertilizer used. Show all calculations. [3 marks]

b. 16.8 g of Calcium nitrate and 17.5 g ammonium fluoride are mixed and react according to the following reaction:
[Atomic mass: Ca = 40.1, N = 14.0, O =16.0, F = 19.0, H = 1.0]

$$Ca(NO_3)_2\ (s) + NH_4F\ (s) \rightarrow CaF_2\ (s) + N_2O\ (g) + H_2O\ (g)$$

(i) Balance the equation. [1 mark]
(ii) Determine which of the two reactants is the limiting reagent. [2 marks]
(iii) If only 7.5 g of N_2O were collected after the reaction, what is the percent yield of the reaction? [2 marks]

c. 100 cm^3 of 2*M* aqueous sodium hydroxide was mixed with 50 cm^3 of 1*M* aqueous sodium hydroxide. Calculate the concentration of the resulting mixture. [4 marks]

d. Acidified potassium manganite(VII) reacts with aqueous hydrogen peroxide, H_2O_2. The equation for the reaction is given below.

$$H_2O_2(aq) + MnO_4^-(aq) + H^+(aq) \rightarrow O_2(g) + Mn^{2+}(aq) + H_2O(l)$$

(i) Balance the equation. [1 mark]
(ii) What is the oxidation state of manganese in MnO_4^- and Mn^{2+}. [2 × 1 mark]
(iii) What type of chemical change happens to the MnO_4^- in the reaction? Give a reason for your answer. [2 × 1 mark]

e. The system is the specific part of the universe that is of interest in the study of thermochemistry. Name the three systems and state the exchange involved in each of them. [3 marks]

Continued.....

Question 2 [20 marks]

a. (i) Use Bohr's equation to calculate how much energy (in J) is needed to promote an electron from the H-atom ground state to the $n = 4$ level. [2 marks]
(ii) If a photon provides the energy in (a), what is its wavelength in nm? [Planck constant , $h = 6.63 \times 10^{-34}$ Js, C = 3.00×10^{8} m/s] [2 marks]

b. (i) How does an electron move to a higher energy level? [1 mark]
(ii) When an electron drops to a lower energy level, how is energy lost? [1 mark]

c. How are each of the following similar and how are they different?

(i) $2p$ and $3p$ orbitals [2 marks]
(ii) $3s$ and $3p$ orbitals [2 marks]
(iii) the orbitals in the $4p$ subshell [2 marks]

d. What do these elements Ca, Sr, and Ba have in common in terms of their electron configuration? Where are they located in the periodic table? [2 × 1 mark]

e. Name the element that corresponds to each of the following: [4 × 1 mark]

(i) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^3$
(ii) alkali metal with the smallest atomic radius
(iii) Group 5A element with the highest ionization energy.
(iv) Period 3 element with the largest atomic radius

f. An oxide ion, O^{2-}, is about twice the size of an oxygen atom. How would you explain this? [2 marks]

Question 3 [20 marks]

a. Compare the Lewis structure of BF_3 and NF_3. Why do these molecules have different shape? [4 marks]

b. Determine the total number of valence electron in each of the following: [4 × 1 mark]

(i) BCl_3
(ii) CH_3CHO
(iii) PH_4^+
(iv) SO_3^{2-}

c. Identify the strongest attractive forces between each of the following molecules: [3 × 1 mark]

(i) CH_3OH
(ii) H_2S
(iii) $CH_3CH_2CH_3$

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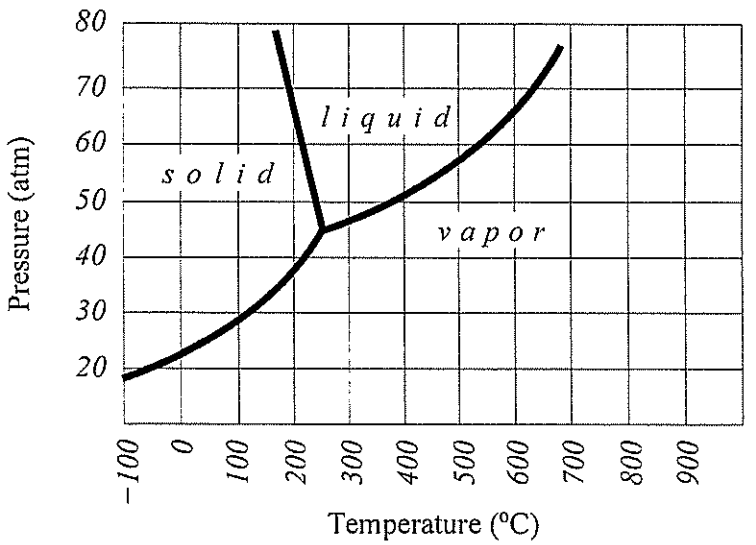
d. What type of crystals are these? [3 × 1 mark]

(i) Osmium tetroxide, OsO_4, is a soft crystal that melts at 40°C.
The liquid does not conduct electricity.
(ii) Boron nitride, BN_3, melts at approximately 3,000°C under high pressure.
This material is almost as hard as diamond.
(iii) Crystals of elemental sulfur are easily crushed, and melt at 113°C.
Liquid sulfur does not conduct electricity.

e. Figure below is a phase diagram of compound *W* that had been discovered beneath the earth's crust. With reference to it, answer the following.



(i) If you should discover a bottle containing compound *W* in your cabinet, what phase would it most likely be in? [1 mark]
(ii) At what temperature and pressure will all 3 phases for compound *W* exist? [1 mark]
(iii) Can compound *W* be boiled in a beaker on your workbench in your lab? Briefly explain your answer. [2 marks]
(iv) At a constant temperature of 200°C, if the pressure were to be increased from 20 atm to 80 atm, what could you observe theoretically? [2 marks]

Question 4 [20 marks]

a. Explain each of the following observations. [2 × 2 marks]

(i) Iron powder burns much more vigorously in oxygen than iron wire does.
(ii) Zinc and sulfuric acid react more quickly when a few drops of aqueous copper(II) sulfate are added.

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b. The rate law for the decomposition of phosphine (PH_3) is rate = $k[PH_3]$. It takes 120 seconds for 4.00 *M* PH_3 to decrease to a concentration of 1.00 *M*. [3 × 2 marks]

(i) Determine the half-life of this reaction.
(ii) Determine the rate constant.
(iii) Determine the time taken for 2.00*M* PH_3 to decrease to a concentration of 0.350*M*.

c. The rate constant for a given second-order reaction with a single reactant is 0.47 $M^{-1}s^{-1}$. If the initial concentration of the reactant is 0.25 M, find the time (t) it takes for the concentration of this reactant to decrease to 0.13 M. [3 marks]

d. The equilibrium constant, K_c, for this reaction is 54.

$$H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$$

If the equilibrium mixture contains 0.030 *M* HI and 0.015 *M* I_2, what is $[H_2]$? [3 marks]

e. Oxygen is converted to ozone (O_3) by the energy provided from an electric spark.

$$3O_2(g) + \text{heat} \rightleftharpoons 2O_3(g)$$

For each of the following changes at equilibrium, indicate whether the equilibrium shifts toward product or reactant or does not shift: [4 × 1 mark]

(i) adding $O_2(g)$
(ii) adding $O_3(g)$
(iii) raising the temperature
(iv) adding a catalyst

Question 5 [20 marks]

a. Aqueous solutions of different acids, with the same concentration, have different pH values.

Acid	Concentration	pH value
Hydrochloric acid	0.10 mol dm^{-3}	1.0
Ethanoic acid	0.10 mol dm^{-3}	3.0

(i) What do you understand by the term 'pH value'? [1 mark]
(ii) How is the pH value related to the concentration of hydrogen ions? [1 mark]
(iii) Explain the difference in the pH values of the two acids. [4 marks]

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b. (i) When ammonium chloride dissolves in water, the ammonium ion donates a proton to water. Write a balanced equation for the reaction of the ammonium ion with water. [2 marks]

(ii) Phosphoric acid dissociates to form dihydrogen phosphate and hydronium ion. Phosphoric acid has K_a of 7.5×10^{-3}. Write the equation and the acid dissociation constant expression for phosphoric acid. [3 marks]

c. A solution with a pH of 3 is 10 times more acidic than a solution with pH 4. Explain. [2 marks]

d. Consider the following:

1. H_2S 2. H_3PO_4 3. HCO_3^-

(i) For each, write the formula of the conjugate base. [1 mark]
(ii) Write the formula of the strongest acid. [1 mark]

e. You are provided 2 test tubes (test tube 1 and test tube 2), each of which contains a solution of NaOH to perform a laboratory task. For test tube 1, the volume of the solution of NaOH is 40 ml and its concentration is 0.50 M. For test tube 2, the volume of the solution of NaOH is 70 ml and the pOH value is 1.00. Based on this information, answer the following.

(i) Calculate the concentration of NaOH in test tube 2. [1 mark]
(ii) If the NaOH solutions in both test tubes 1 and 2 are transferred into a 1-litre volumetric flask and added with distilled water until the 1-litre mark, what would be the pOH of the newly diluted 1-litre NaOH solution in the volumetric flask? [4 marks]

End of Paper